International Journal of Research in Medical Sciences
Anto L et al. Int J Res Med Sci. 2022 Mar;10(3):580-585
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012

DOI: https://dx.doi.org/10.18203/2320-6012.ijrms20220504

Original Research Article

The relationship between smartphone addiction and sleep quality in college students of the faculty of medicine, Sam Ratulangi university

Lie Anto[1]*, Herlyani Khosama[2], Mieke Kembuan[2]

[1]Department of Neurology, [2]Sleep Disorders Division, Department of Neurology, Faculty of Medicine, Sam Ratulangi University/ Prof. Dr. R.D. Kandou Hospital, Manado, Indonesia

Received: 06 January 2022
Revised: 02 February 2022
Accepted: 04 February 2022

***Correspondence:**
Dr. Lie Anto,
E-mail: lieanto22@gmail.com

ABSTRACT

Background: Excessive smartphone use affects sleep quality. The purpose of this study was to see the relationship between smartphone usage and sleep quality.
Methods: Respondents were selected consecutively and asked to fill out the smartphone addiction scale-short version (SAS-SV), Pittsburgh sleep quality index (PSQI) questionnaires via google form and measure sleep quality objectively with sleep tracker (Fitbit charge 2™). Datas were analyzed using SPSS version 25.
Results: There were 62 subjects included in this study, the majority were women (74.2%), the average age was 21 years old. A total of 69.4% are addicted to smartphones. Assessment with PSQI found that 71% showed poor sleep quality, while with Fitbit charge 2™, good sleep quality was obtained, namely sleep latency (100%), sleep efficiency (75.8%), light sleep (61.3%), and deep sleep (82.3%). Waking 5 minutes (50%) is uncertain. Poor sleep quality, namely wake after sleep onset (WASO) by 77.4% and rapid eye movement (REM) by 59.7%. The relationship between smartphone addiction and subjective sleep quality (PSQI) was significant at p=0.007. Smartphone addiction and sleep quality measured by objective parameters seemed insignificant (wake up 5 minutes p=0.884, WASO p=0.848, sleep efficiency p=701, light sleep p=0.629, deep sleep p=0.240, REM p=0.638).
Conclusions: There is a relationship between smartphone addiction and sleep quality using subjective measurement (PSQI), but not with a sleep tracker.

Keywords: Smartphone addiction, Sleep quality, PSQI, Fitbit charge 2™

INTRODUCTION

Sleep is an important factor for restoring physical function and maintaining health.[1] Sleep quality affects a person's quality of life.[2-5] Sleep quality is a complex phenomenon consisting of quantitative components as well as qualitative elements that can vary between individuals. Although sleep quality can be understood clinically, sleep quality has a subjective component that is difficult to define and measure objectively.[6] A person's sleep quality is influenced by several internal and external factors including pain, anxiety or stress, lighting, environment, jetlag, medicine, and shift-based work.[7-9]

Excessive use of smartphones is one of the important factors that affect the quality of sleep of users and can be a sign of someone experiencing smartphone addiction.[10] Measurement of sleep quality can be done with subjective and objective measurements. This study uses subjective measurements using the PSQI and objective measurements using a sleep tracker including sleep continuity and sleep architecture. The gold standard for studying sleep physiology is polysomnographic assessment (PSG). However, this methodology has limitations and another simple measurement can be considered for the characterization of sleep quality.

Among them are the use of sleep trackers and PSQI questionnaires.[11]

Sleep trackers are used to monitoring various actions, such as sleep patterns and activity. One type of sleep tracker that is often used is ®Fitbit Charge 2. Research conducted by Zambotti et al in America evaluated the performance of ®Fitbit Charge 2 by comparing it with polysomnography (PSG) in measuring sleep stages, it was found that ®Fitbit Charge 2 showed a sensitivity of 0, 96 (accuracy for detecting sleep), 0.61 specificity (accuracy for detecting wakefulness), 0.81 accuracies in detecting NREM phase sleep 1-2, 0.49 accuracy in detecting NREM sleep phase 3-4, and 0.74 accuracies in detecting REM sleep. ®Fitbit Charge 2 shows satisfactory results in detecting sleep-wake and sleep stages compared to the PSG gold standard, especially in REM sleep estimation, but with limitations in NREM phase-detection 3-4.[12,13]

The PSQI was to measure sleep quality. PSQI is known as an international standard instrument and has been made in various language versions and is reported to have a good level of validity and reliability with a diagnostic sensitivity of 89.6%, specificity of 86.5%, and p<0.00l in distinguishing good and bad sleep.[6]

Several studies have been conducted to assess the relationship between smartphone addiction and sleep quality. However, all the studies did not use objective measurement.[10,14,15] Based on several studies, it was found that excessive use of smartphones can indicate addiction and cause disruption of sleep quality. Sleep quality can be assessed subjectively and objectively. Subjective examination using the PSQI questionnaire and objectively using the sleep tracker Fitbit Charge 2. Smartphone addiction and sleep quality have been widely studied by measuring sleep quality subjectively using the PSQI questionnaire, but objective measurements have not been widely carried out so that authors desire to examine smartphone addiction with sleep quality objectively.[11-17]

METHODS

Research design

This study used an analytical observational design with a cross-sectional approach to students at the faculty of medicine, Sam Ratulangi university in Manado, North Sulawesi, Indonesia

Place and time of research

Data collection activities are carried out online and data processing at prof. Dr. R. D. Kandou hospital Manado. A sampling of data began in January 2021-March 2021, after the researcher's received approval from the ethics committee of Prof. Dr. R. D. Kandou hospital Manado, Indonesia

Research sample

The research sample was conducted using non-probability consecutive sampling. All students in the affordable population who met all inclusion requirements and did not have any of the exclusion criteria were sampled in this study.

Accessible population-there were 69 students seventh semester from the faculty of medicine, Sam Ratulangi university.

Inclusion and exclusion criteria

Inclusion criteria for students in the accessible population to be the research sample include the following circumstances at the time of their visit: 7th semester students who are registered in the portal of the Faculty of Medicine, Sam Ratulangi university who are domiciled in Manado and its surroundings, is in good health, willing to participate in the study by signing the informed consent and using a smartphone.

Subjects are excluded if: students who have pain disorders, parasomnias, sleep breathing disorders (using a research questionnaire) and depression {using the Hamilton depression rating scale (HDRS) questionnaire}, taking sleeping pills for the past few months and consuming alcohol, smoking and coffee (6 hours before bedtime).

Calculation of sample size

The relationship between smartphone addiction and sleep quality in faculty of medicine students is a one-group test with a known population. Therefore, the sample size is determined based on the Slovin formula.

The Slovin formula for determining the sample is as follows:

$$N=N/1+N(e)^2$$

N=Minimum number of samples required,
N=Total population=69 people,
e=Error tolerance limit=5%

The fault tolerance limit is expressed as a percentage. The smaller the error tolerance, the more accurately the sample represents the population. For example, research with an error limit of 5% means it has an accuracy rate of 95%. In this study, it was determined that the error tolerance limit was 5%=0.05.

Based on the formula, then n=69 / 1 + 69(0.05)2=58.8

Then the results obtained that the minimum number of samples needed in this study was 59 respondents (after rounding).

Procedure

The study was conducted on subjects who met the inclusion criteria in the following order: Sampling was carried out on faculty of medicine students in Manado. The researcher introduces himself and explains the purpose of the research to be conducted online to the 7th-semester students of the faculty of medicine, Sam Ratulangi university. The researcher asks the respondent for approval, if the respondent agrees, invites them to sign the informed consent. Researchers identify research subjects who are students of the faculty of medicine, Sam Ratulangi university. Collecting identity data in the form of a name, gender, age, semester, and student identification number to avoid double recording. Anamnesis to determine the history of the previous disease as well as to rule out exclusion criteria. The researcher explained how to fill out the PSQI questionnaire and the smartphone addiction SAS-SV questionnaire to respondents. Respondents submit questionnaires to researchers via a google form. Research subjects were given information about using a sleep tracker to use at night before going to bed and taught how to download an application on a smartphone so that the data recorded last night could be displayed in the application. Respondents submit the results of sleep quality measurements to researchers. Data were analyzed using SPSS.

RESULTS

Research subjects who participated in the study amounted to 62 students. The characteristics of the respondents, namely the majority are female, which is 74.2% (n=46) with an average age of 21 years. The youngest is 20 years old and the oldest is 23 years old. A total of 43 respondents or 69.4% experienced smartphone addiction. The number of men who are addicted to smartphones is 13 people (81.2%) and women who are addicted to smartphones are 30 people (65.2%). The results of statistical analysis using the chi-square correlation test obtained a non-significant relationship between gender and smartphone addiction (p>0.05).

The average student who has poor sleep quality based on the PSQI questionnaire, namely the average PSQI score of 8 (1-21) where if the PSQI score >5 is poor sleep quality. Of the 62 study samples, 29% (n=18) had good quality and 71% (n=44) had poor sleep quality

Sleep latency parameters, a median of 5 minutes was obtained for respondents in the study. All respondents (100%) obtained sleep latency which indicates good sleep quality. The median value of waking up 5 minutes was obtained 2.5 times in respondents in the study. Respondents who showed good sleep quality were 19.4% waking up in 5 minutes (n=12), 50% uncertain (n=31), and 30.6% disturbed sleep quality (n=19). The median assessment of WASO was 50.5 minutes for respondents in the study. All respondents found that WASO did not show good sleep quality, 22.6% (n=14) uncertain, and 77.4% (n=48) disturbed sleep quality. Sleep efficiency obtained a median of 87.41% in research respondents. Respondents who showed good sleep quality were sleep efficiency of 75.8% (n=47) and uncertain of 24.2% (n=15). The mean value of light sleep is 50.43%. Light sleep which shows good sleep quality is 61.3% (n=38) and disturbed sleep quality is 38.7% (n=24). Assessment of deep sleep obtained a mean value of 16.26% in research respondents. Research respondents got deep sleep which showed good sleep quality by 82.3% (n=51) and disturbed sleep quality by 17.7% (n=11). The mean value of REM is 19.49%. Research respondents obtained REM which shows good sleep quality by 40.3% (n=25) and disturbed sleep quality by 59.7% (n=37).

Respondents who are addicted to smartphones and have poor sleep quality based on measurements using the PSQI questionnaire are 35 respondents (79.5%). The relationship between smartphone addiction and sleep quality based on the measurement of the PSQI questionnaire was tested statistically. Smartphone addiction was significant if it was associated with sleep quality as seen from the p=0.007 (<0.05). The details are shown in Table 1.

The relationship between smartphone addiction and sleep quality sleep latency cannot be assessed because of a single variable. Smartphone addiction and sleep quality measured by the 5-minute wake-up parameter showed a non-significant relationship (p=0.884). The relationship between smartphone addiction and sleep quality with the parameter WASO was found to be insignificant with p=0.848. Smartphone addiction did not appear to be significant if it was associated with sleep quality with sleep efficiency parameters (p=0.701). The relationship between smartphone addiction and light sleep quality was not significant (p=0.629). Smartphone addiction seemed insignificant when it was associated with deep sleep quality (p=0.240). The relationship between smartphone addiction and sleep quality using REM parameters did not appear to be significant as seen from the p=0.638 (Table 2).

Table 1: Relationship between smartphone addiction and sleep quality based on the measurement of the PSQI questionnaire (subjective), (n=62).

Variable		Smartphone addiction		P value	OR (95% CI)
		Yes (%)	No (%)		
PSQI	≤5	8 (44.4)	10 (55.6)	0.007	4.861 (1.488-15.877)
	>5	35 (79.5)	9 (20.5)		

Table 2: Relationship between smartphone addiction and sleep quality parameters based on sleep tracker measurements (objective), (n=62).

Variables		Smartphone addiction		P value	OR (95% CI)
		Yes (%)	No (%)		
Sleep latency (Min)	≤ 30	43 (69.4%)	19 (30.6)	-	1.400 (0.290-6.769)
	31-45	-	-		
	> 45	-	-		
Wake up 5 minutes	≤ 1 time	8 (66.7)	4 (33.3)	0.884	1.333 (0.375-4.742)
	2-3 times	21 (67.6)	10 (32.3)		
	≥ 4 times	14 (73.7)	5 (26.3)		
WASO (Min)	≤ 20	-	-	0.848	0.880 (0.237-3.263)
	21-40	10 (71.4)	4 (28.6)		
	>40	33 (68.8)	15 (31.3)		
Sleep efficiency (%)	≥ 85	32 (68.1)	15 (31.9)	0.701	1.289 (0.352- 4.722)
	65-84	11 (73.3)	4 (26.7)		
	≤ 64	-	-		
Light sleep (%)	47-60	25 (65.8)	13 (34.2)	0.629	1.560 (0.498-4.885)
	<47%, >60%	18 (75)	6 (25)		
Deep sleep (%)	13-23	37 (72.5)	14 (27.5)	0.240	0.454 (0.119-1.728)
	<13, >23	6 (54.5)	5 (45.4)		
REM	20-25	16 (64)	9 (36)	0.638	1.519 (0.509-4.528)
	<20, >25	27 (73)	10 (27)		

DISCUSSION

The relationship between smartphone addiction and sleep quality based on the measurement of the PSQI questionnaire (subjective) was statistically tested. Smartphone addiction was significant if it was associated with sleep quality as seen from the p=0.007 (<0.05).

This study is similar to previous studies.[10,14,15] Research on smartphone addiction and sleep quality in college students was conducted by Demirci et al in Turkey. The results showed that smartphone addiction was positively correlated with the PSQI global score (r=0.156, p=0.014), the subjective sleep quality component of the PSQI (r=0.138, p=0.030), the PSQI sleep disorder component (r=0.153, p=0.016), and the PSQI daytime dysfunction component (r=0.244, p<0.001), this result may be due to sleep dysregulation.[24]

This finding according to this study may be caused by exposure to smartphone screen light from smartphones before bed can affect the onset time and melatonin secretion, which in turn disrupts sleep-wake rhythm. This can be assessed on the PSQI questionnaire, namely subjective sleep quality (subjective sleep quality), sleep latency (sleep latency), sleep duration (sleep duration), effective sleep duration in bed (habitual sleep efficiency), sleep disturbance (sleep disturbance), use of sleeping medication (sleep medication), and daytime dysfunction.[10]

The relationship between smartphone addiction and sleep quality sleep latency cannot be assessed because of a single variable. Sleep latency in this study found 100% of respondents showed good sleep quality, this may be due to the difference in measuring instruments used in this study which is less sensitive in assessing sleep latency parameters when compared to the gold standard using polysomnography. Smartphone addiction and sleep quality measured by the 5-minute wake-up parameter showed a non-significant relationship (p=0.884). The relationship between smartphone addiction and sleep quality with the WASO parameter was not significant (p=0.848). Smartphone addiction was not significant when it was associated with sleep quality, sleep efficiency parameters (p=0.701). The relationship between smartphone addiction and light sleep quality was not significant (p=0.629). Smartphone addiction seemed insignificant when it was associated with deep sleep quality (p=0.240). The relationship between smartphone addiction and sleep quality using REM parameters did not appear to be significant as seen from the p=0.638.

This study of smartphone addiction with subjective and objective sleep quality was also evaluated by Sonawane et al in India using SAS for smartphone addiction, the PSQI questionnaire for subjective sleep quality, and Fitbit charge 2™ for objective sleep quality. Objective sleep measurement using Fitbit Charge 2™ for 5 days of sleep. Sleep evaluation includes deep sleep, light sleep, rapid eye movements sleep (REM sleep), and wake time.[16,25]

The results showed that there was a positive correlation between SAS and PSQI sleep scores with a p<0.0001. Other parameters such as light sleep (LS), deep sleep (DS), REM showed insignificant results. The results of this study indicate that there is a positive correlation between smartphone addiction and sleep quality in young adults. This result can be attributed to the fact that

smartphone dependence or excessive use can harm sleep due to exposure to bright screen light or electromagnetic radiation or both.[25]

In a study conducted by Loughran et al it was reported that there is a change in the sleep electroencephalogram if a person is exposed to a smartphone before going to bed.[6,9] Various studies have assumed that reduced melatonin production on exposure to bright light or electromagnetic fields, especially at night, causes a decrease in melatonin and is the reason for the disturbance. sleep quality.[25,26]

Huber et al reported that more smartphone use at night has an impact on many physiological factors such as sleep quality and melatonin regularity, possibly by influencing brain activity especially the pineal gland which can also cause changes in cerebral blood flow and brain electrical activity.[26]

Research conducted by Hysing et al revealed that the use of electronic devices during the day and at bedtime can cause short sleep duration, long sleep onset latency, and sleep insufficiency and ultimately lead to a reduction in daily work activities.[27] Dworak et al also reported that excessive use of smartphones or the internet can affect sleep quality, because it reduces REM sleep, deep sleep, and sleep efficiency or suppresses the onset time of melatonin secretion and delays in early sleep due to bright light from gadget screens in the middle of the night.

Several mechanisms are thought to explain the negative effects of smartphone use on sleep quality. First, prolonged use of mobile phones directly reduces the time users spend sleeping, particularly smartphone use before bedtime, resulting in sleep deprivation. Second, some mobile users prefer to browse websites before going to bed. This state can make the user feel tension and excitement, which causes difficulty in initiating sleep. Third, excessive smartphone use can affect sleep through several physiological and psychological pathways. For example, exposure to smartphone screen light and radiation from cell phones during bedtime can affect the timing of onset and secretion of melatonin, which in turn disrupts sleep-wake rhythms.[28,29]

Objective research using a sleep tracker in measuring sleep quality parameters was found to be insignificant, perhaps because the instrument used in this study had lower sensitivity in measuring certain sleep stages or parameters compared to the gold standard measurement using polysomnography.

This study still has limitations, namely the sampling technique used is non-probability consecutive sampling which does not fully guarantee that the research sample is representative of the entire student population, so it has the potential to cause bias in this study. This research questionnaire was filled out online via a Google form by distributing links to participants. Even though an explanation has been given regarding how to fill in, there is a possibility that the participants did not understand the question and there was an error in filling out the Goggle Form. Objective measurements carried out 1 night have the potential to cause bias, respondents may know that the quality of sleep will be measured that night so that they have prepared themselves and have the potential to be biased in the measurement results. Sleep measurement using the Fitbit charge 2 also has limitations compared to the gold standard measurement using polysomnography. The Fitbit charge 2 sleep tracker has a lower sensitivity in measuring specific sleep stages than polysomnography. The Fitbit charge 2 sleep tracker uses a combination of movement and heart rate variability (HRV) to measure sleep, while polysomnography uses more complex parameters including the ability to record electrical activity in the brain.

CONCLUSION

Smartphone addiction in the faculty of medicine students is high, mostly in men. Sleep quality in the faculty of medicine, Sam Ratulangi university students is poor with subjective measurements (PSQI) and with objective measurements (Fitbit charge 2 sleep tracker) which is partially good. There is a relationship between smartphone addiction and sleep quality using subjective measurement (PSQI), there is no relationship found using objective measurement (Fitbit charge 2 sleep tracker).

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Cates ME, Clark A, Woolley TW, Saunders A. Sleep Quality Among Pharmacy Students. Am J Pharm Educ. 2015;79(1):09.
2. Rafknowledge. Insomnia dan gangguan tidur lainnya. Jakarta: Penerbit PT Elex Media Komputindo. 2004.
3. Dobing S, Frolova N, McAlister F, Ringrose J. Sleep Quality and Factors Influencing Self-Reported Sleep Duration and Quality in the General Internal Medicine Inpatient Population. Eckle T, editor. PLoS ONE. 2016 ;11(6):e0156735.
4. Tasdemir S, Oguzhan O. The factors influencing sleep quality. Ann Indian Acad Neurol. 2016;19(3):422.
5. Vicente De Carvalho JS, Oliveira I, Rosa R, Barata C, Fradinho M, Oliveira L et al. Sleep quality and quality of life in physicians and nurses working at a Central Hospital. In: Sleep and control of breathing. Eur Respiratory Society. 2018;PA4372.
6. Sukmawati NMH, Putra IGSW. Reliabilitas Kusioner Pittsburgh Sleep Quality Index (Psqi) Versi Bahasa Indonesia Dalam Mengukur Kualitas Tidur

Lansia. Wicaksana: Jurnal Lingkungan dan Pembangunan. 2019;3(2):30-8.
7. Lo HM, Leung JHY, Chau GKY, Lam MHS, Lee KY. Factors Affecting Sleep Quality among Adolescent Athletes. Sports Nutr Ther. 2017;02(02):123.
8. Yilmaz D, Tanrikulu F, Dikmen Y. Research on Sleep Quality and the Factors Affecting the Sleep Quality of the Nursing Students. Current Health Sci J. 2017;(1):20-4.
9. Altun I, Cınar N, Dede C. The contributing factors to poor sleep experiences in according to the university students: A cross-sectional study. J Res Med Sci. 2012;17(6):557-61.
10. Pandey CM, Ratag BT, Langi FLFG. Hubungan Antara Kecanduan Smartphone Dengan Kualitas Tidur Pada Siswa Sma Negeri 1 Maesaan Kabupaten Minahasa Selatan. Kesmas. 2019;8(2).
11. Krystal AD, Edinger JD. Measuring sleep quality. Sleep Medicine. 2008;9:S10-7.
12. Lee H-A, Lee H-J, Moon J-H, Lee T, Kim M-G, In H et al. Comparison of Wearable Activity Tracker with Actigraphy for Sleep Evaluation and Circadian rest-activity Rhythm Measurement in Healthy Young Adults. Psychiatry Investig. 2017;14(2):179.
13. De Zambotti M, Goldstone A, Claudatos S, Colrain IM, Baker FC. A validation study of Fitbit Charge 2™ compared with polysomnography in adults. Chronobiology Int. 2018;35(4):465-76.
14. Asiyah SN, Putri AY. Relationship Between Smartphone Addictions with Sleep Quality in Adolescents. ICHIRO. 2018;1(0):92-9.
15. Tarlemba F, Asrifuddin A, Langi FLFG. Hubungan Tingkat Stres Dan Kecanduan Smartphone Dengan Gangguan Kualitas Tidur Pada Remaja Di Sma Negeri 9 Binsus Manado. Kesmas. 2019;7:5.
16. Sonawane PP, Mahajan A, Shinde CS. Association Between Smartphone Addiction and Sleep Quality along with Objectively Measured Sleep. Ind J Physioth Occupat Therapy. 2019;13(4):91.
17. Miller CB, Kyle SD, Melehan KL, Bartlett DJ. Methodology for the Assessment of Sleep. In: Sleep and Affect. Elsevier; 2015;65-90.
18. Lailiyya N. Panduan Tatalaksana Ganggun Tidur. Jakarta: Sagung Seto. 2018;2.
19. Horner RL, Peever JH. Brain Circuitry Controlling Sleep and Wakefulness: Continuum. Lifelong Learning in Neurol. 2017;23(4):955-72.
20. Kryger MH. Atlas of clinical sleep medicine. Second edition. Philadelphia, PA: Elsevier/Saunders. 2013;511.
21. Themes UFO. Sleep Disorders in Child Neurology. Neupsy Key. 2016. Available at: https://neupsykey.com/sleep-disorders-in-child-neurology/. Accessed on 2020 Jun 7
22. Crivello A, Barsocchi P, Girolami M, Palumbo F. The Meaning of Sleep Quality: A Survey of Available Technologies. IEEE Access. 2019;7:167374-90.
23. M Handojo, Pertiwi MJ. Hubungan Gangguan Kualitas Tidur Menggunakan Psqi Dengan Fungsi Kognitif Pada Ppds Pasca Jaga Malam: Relationship Between Sleep Quality Disabled Using Psqi With Cognitive Function At Pasca Ppds Night Paper. sinaps. 2018;1(1):91-101.
24. Cain N, Gradisar M. Electronic media use and sleep in school-aged children and adolescents: A review. Sleep Medicine. 2010;11(8):735-42.
25. Ohayon M, Wickwire EM, Hirshkowitz M, Albert SM, Avidan A, Daly FJ et al. National Sleep Foundation's sleep quality recommendations: first report. Sleep Health. 2017;3(1):6-19.
26. Kyba C, Kantermann T. Does ambient light at night reduce total melatonin production? HJ. 2015. Available at: http://www.hormones.gr/8587/article/does-ambient-light-at-night-reduce%E2%80%A6.html. Accessed on 2020 June 28.
27. Huber R, Treyer V, Borbely AA, Schuderer J, Gottselig JM, Landolt H-P, et al. Electromagnetic fields, such as those from mobile phones, alter regional cerebral blood flow and sleep and waking EEG. J Sleep Res. 2002;11(4):289-95.
28. Hysing M, Pallesen S, Stormark KM, Jakobsen R, Lundervold AJ, Sivertsen B. Sleep and use of electronic devices in adolescence: results from a large population-based study. BMJ Open. 2015;5(1):e006748.
29. Ikeda K, Nakamura K. Association between mobile phone use and depressed mood in Japanese adolescents: a cross-sectional study. Environ Health Prev Med. 2014;19(3):187-93.
30. Cain N, Gradisar M. Electronic media use and sleep in school-aged children and adolescents: A review. Sleep Medicine. 2010;11(8):735-42.

Cite this article as Anto L, Khosama H, Kembuan M. The relationship between smartphone addiction and sleep quality in college students of the faculty of medicine, Sam Ratulangi university. Int J Res Med Sci 2022;10:580-5.